(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 January 2001 (25.01.2001)

PCT

(10) International Publication Number
WO 01/05245 A1

(51) International Patent Classification[7]: A23K 1/18

(21) International Application Number: PCT/DK00/00369

(22) International Filing Date: 6 July 2000 (06.07.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PA 1999 01041 20 July 1999 (20.07.1999) DK

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/05245 A1

(54) Title: A METHOD OF FEEDING PIGLETS IN A WEANING PERIOD, A WEANING FEED FOR PIGLETS AND THE USE OF A SPECIAL FAT FOR THE MANUFACTURE OF A WEANING FEED

(57) Abstract: A method of feeding piglets in a weaning period, the use of a special fat for the manufacture of a weaning feed for piglets and a weaning feed comprising such a special fat are disclosed. The method comprises feeding the piglets with a feed composition comprising from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2. The special fat can be obtained by enzymatic or chemical interesterification of long chain triglycerides with short or medium chain triglycerides or with short or medium chain fatty acids or esters thereof in the prescribed molar ratios.

A method of feeding piglets in a weaning period, a weaning feed for piglets and the use of a special fat for the manufacture of a weaning feed.

This invention concerns a method of feeding piglets in a weaning period and a weaning feed for piglets. In particular, it concerns the use of a special fat for the manufacture of a weaning feed for piglets

BACKGROUND OF THE INVENTION

Piglets are born with very small energy depots mainly consisting of glycogen and virtually no adipose tissue. Thus, they are very dependent on sow's milk. Until weaning at 3-4 weeks of age they practically only receive sow's milk. From the day of weaning they solely receive a weaner or starter diet presented as solid feed or as wet or fermented feed. Suckling pigs digest the nutrients in sow's milk very efficiently. The apparent digestibility of milk fat is reported to be 96-100%. The high digestibility of fat during the suckling period is seen in spite of a low level of the most important lipolytic enzyme, pancreatic lipase. At weaning the digestibility of fat declines from 80% to 65% (K.R. Cera, D.C. Mahan and G.A. Reinhart, 1990, *J. Anim. Sci.* 66, 1430).

The gastrointestinal system has to adapt to the considerable changes in the physico-chemical properties of the feed as well as to a change in the pattern of intake in order to satisfactorily digest and absorb the nutrients in the diet and maintain an acceptable growth rate.

Own investigations have shown that pancreatic enzyme activities are low before weaning, that the activity drops at weaning and remains low 1-2 weeks after weaning and may not have reached maximum level at 8 weeks of age (M.S. Jensen, S.K. Jensen and K. Jakobsen, 1997, *J. Anim.*

Sci. **75**, 437-445). Also liver function and thus bile secretion has been reported to be fully developed at about 8 weeks of age.

Thus, the pig is not fully developed to digest and absorb the feed components until about 8 weeks of age.

Under practical farming conditions the weaning period is a difficult time both for the pig and the farmer. Loss of appetite, loss of weight and diarrhoea are often encountered which may lead to death. Therefore, it is often practised that the piglets receive starter feed or weaner diet from 2 weeks of age while they receive sow's milk to adapt them to solid feed. Also, it is practice to reduce the feed intake or avoid it on the day of weaning allowing only free access to water or an electrolyte solution. From weaning and up to 4 weeks after weaning a starter diet or weaner diet is used. This should be characterized by including highly digestible feed components in adequate amounts. Many efforts have been and are being done in order to optimize the composition of this diet. Often this diet costs DKK 1-2 more per kg than a grower diet. It contains antibiotic growth promoters, probiotics or other alternatives to antimicrobial growth promoters. After the ban of certain antibiotic growth promoters within the EC and a voluntary ban of antibiotic growth promoters in pigs up to 35 kg LW by the pig producers from the year 2000, the efforts to develop alternatives or to avoid growth promoters are increasing. Often enzymes are added. Because of a high growth potential, animal fat is often used as a cheap energy source in amounts up to 10%. As it is digested only about 70-80%, lecithins may be added as solubilizers, although the beneficial effect is questioned.

Own studies (A. Chwalibog, K. Jakobsen and G. Thorbek, 1994, *J. Anim. Physiol. and Anim. Nutr.* **72**, 80-85) showed that the growth potential of pigs at 15-20 kg LW was so high that the energy requirement was covered by oxidation of body fat. It was concluded that the diet should contain 5-7% fat to obtain an intake of metabolizable energy of 1.1-1.2 $MJ/kg^{0.75}$, which would ensure a maximum protein gain without loss of body fat, provided the protein intake is adequate.

Overall, it can be concluded that the intake of fat in pigs from weaning at 3-4 weeks of age or earlier until about 8 weeks represents a critical point as to digestibility and energy source and hence to the vitality and health of the weaning pig.

Carl-Erik Høy and co-workers have studied the absorption of specific oils with defined or random structure in rats with deficient pancreatic and bile secretions (M.S. Christensen, A. Müllertz and C.-E. Høy, 1995, *Lipids* **30**, 521-526). Using a rat model of malabsorption, they compared the absorption of structurally defined triglycerides with medium chain fatty acids (MCFA) mainly 8:0/10:0 in the sn-1.3 positions and polyunsaturated fatty acids (18:2n-6 and 18:3n-3) in the sn-2 position (MLM) resulting from enzymatic interesterification of soybean oil with MCFAs, the absorption of similar triglycerides resulting from chemical randomization of soybean oil with the same MCFAs, the absorption of a physical mixture of soybean oil and triglycerides having the same MCFA residues, and the absorption of soybean oil, respectively. They found a significantly higher lymphatic level of the essential fatty acids at administration of structurally defined triglycerides compared to the other fats. Lymphatic absorption of MCFA was similar in the three first groups, but not as efficient as for the long

chain fatty acids. Thus the intestinal absorption of fatty acids seemed to be influenced by triglyceride structure and the absorption of fatty acids located in the sn-2 position seemed to be favoured.

It is known that MCFA (6:0-12:0) are utilized as an energy source to a greater extent than long chain fatty acids. Trioctanoin (8:0) was oxidized more efficiently than triolein (18:1) in studies with neonatal piglets (S.H. Chiang, J.E. Pettigrew, S.D. Clarke and S.G. Cornelius, 1990, *J. Anim. Sci.* **68**, 1632-1638).

Further, the European Patent Application, Publication No. 600 439 describes a method of breeding an infant livestock, e.g. newborn piglets, which comprises orally administering a liquid feed composition comprising fats and oils having a fatty acid composition comprising 10 % by weight or more of a saturated fatty acid having 6 to 12 carbon atoms to a newborn livestock within 24 hours from its birth.

OBJECT OF THE INVENTION

The present invention is about a method of feeding piglets in a weaning period, not about supplying energy to newborn piglets or to adult rats that have been pancreatic duct and bile duct diverted.

The purpose of the invention is to provide an oil, which will at the same time provide the weaning pig with readily available energy (be oxidized readily to provide energy for protein deposition) and lipid for storage and membrane structuring.

Our investigations have shown that a special fat which is ideally suited for this purpose is a so-called specifically structured lipid (SSL) comprising triglycerides

having short or medium chain, mainly saturated fatty acid residues predominantly occupying the sn-1.3 positions and long chain mainly unsaturated, preferably polyunsaturated fatty acid residues predominantly occupying the sn-2 positions.

Such specifically structured lipids are made by enzymatic interesterification of triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues with triglycerides having short or medium chain mainly saturated fatty acid residues or with short or medium chain mainly saturated fatty acids or esters thereof by means of a regiospecific (1,3-specific) lipase. But, at present, the costs of using enzymatic interesterification make this procedure irrelevant. Therefore, in addition to enzymatic interesterification of a vegetable oil (rapeseed oil was used) with capric acid, chemical hydrolysis and esterification of rape seed oil with tricaprin was used, and the resulting oils as well as a physical mixture of rape seed oil and tricaprin were compared with the pure oil in a digestibility and balance study of piglets in a weaning period. Similarly, chemical interesterification of rape seed oil with tricaprin and coconut oil, respectively, was used, and the resulting oils as well as a physical mixture of rape seed oil and coconut oil were compared with the pure oil in a production study of piglets in a weaning period.

The results showed that by feeding piglets in a weaning period with a feed composition comprising an enzymatically or chemically interesterified oil the following advantages were obtained:

- a better utilization of the feed,
- a better digestibility of the fat content,
- a better nitrogen retention (daily protein deposition),

- a better protein deposition in percent of digested protein.

Further, in the production study the incidence of diarrhoea was lower among the piglets receiving this special fat than among the control piglets receiving ordinary weaning feed, and thus it may also be expected that piglets receiving the special fat in connection with weaning will have a lower death rate.

SUMMARY OF THE INVENTION

Accordingly, the invention provides a method of feeding piglets in a weaning period which comprises feeding the piglets with a feed composition comprising from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

Such a special fat can i.a. be obtained by enzymatic or chemical interesterification of triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues with triglycerides having short or medium chain mainly saturated fatty acid residues or with short or medium chain mainly saturated fatty acids or esters thereof in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

Generally, the long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues are selected from

the group consisting of fatty acid residues of from 16 to 24 carbon atoms, preferably from 18 to 22 carbon atoms, and the short or medium chain mainly saturated fatty acid residues or fatty acids are selected from the group consisting of fatty acid residues and fatty acids of from 6 to 14 carbon atoms, preferably from 8 to 12 carbon atoms, and more preferably from 8 to 10 carbon atoms.

In particular, the special fat can be a so-called specifically structured lipid (SSL) comprising triglycerides with short or medium chain fatty acid residues mainly occupying the sn-1.3 positions and long chain fatty acid residues mainly occupying the sn-2 positions, obtained by enzymatic interesterification with a lipase.

More broadly, the special fat can be a chemically interesterified triglyceride mixture comprising triglycerides with short or medium chain fatty acid residues and long chain fatty acid residues occupying random positions.

Suitable special fats are obtained by enzymatic or chemical interesterification of a vegetable or animal oil consisting of triglycerides with fatty acid residues having chain lengths in the range of from 18 to 22 carbon atoms with fatty acids having chain lengths in the range of from 8 to 12 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with such fatty acid residues. More specifically, suited special fats are obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with fatty acids of predominantly 8 and 10 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with predominantly such fatty acid residues.

In another aspect, the invention provides a method of feeding piglets in a weaning period which comprises feeding the piglets with a feed composition comprising from 2

to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue.

It is conceivable that such a special fat could be obtained by genetic modification of a vegetable oil producing plant or a microorganism.

In advantageous embodiments of both aspects of the method according to the invention the feed composition is a basic weaning feed for piglets to which 4 to 15 percent by weight, preferably 6 to 12 percent by weight of said special fat has been added.

According to the method of the invention the piglets are fed with the feed composition containing said special fat in the first period after weaning. Ordinarily, this means that the piglets are fed with said feed composition during a weaning period within their 3rd to 8th week of life (i.e from age 2 weeks to age 8 weeks). The most significant results are obtained when they are fed with said feed composition during the first two weeks after weaning. In Denmark where the piglets are normally weaned at about age 4 weeks, they will be fed with said feed composition during their 5th to 6th week of life, and, if desired, during their 5th to 8th week of life; but they may be given access to said feed composition during their 3rd week of life along with the sow's milk in order to adapt them to solid feed.

The invention also includes the use of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly

saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2, for the manufacture of a weaning feed for piglets.

The ways of obtaining the special fat as well as the preferred chain length distribution of the fatty acid residues in the triglycerides of the special fat and the preferred starting materials for its preparation are as defined above for the feeding method according to the invention.

Likewise, the invention includes the use of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue, for the manufacture of a weaning feed for piglets.

Further, the invention includes a weaning feed for piglets which comprises from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

Again, the ways of obtaining the special fat as well as the preferred chain length distribution of the fatty acid residues in the triglycerides of the special fat and the preferred starting materials for its preparation are as defined above for the feeding method according to the invention.

Likewise, the invention includes a weaning feed for piglets which comprises from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue.

In a preferred embodiment the weaning feed according to the invention is a basic weaning feed for piglets to which 4 to 15 percent by weight, preferably 6 to 12 percent by weight of the special fat has been added.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1-3 are graphs depicting the results of the digestibility and balance study reported in Example 1 below with piglets allotted feed containing rapeseed oil (Group 1), chemically (randomly) interesterified rapeseed oil and tricaprin (Group 2), enzymatically (structurally) interesterified rapeseed oil and tricaprin (Group 3), and a physical mixture of rapeseed oil and tricaprin (Group 4), respectively.

Figure 1 shows digestibility of fat (percent) in the four groups.

Figure 2 shows daily protein deposition in the piglets of the four groups.

Figure 3 shows the piglets' protein deposition in percent of digested protein (biological value).

Figures 4-6 are block diagrams depicting the results of the production study by *ad lib.* feeding reported in Example 2 below with piglets allotted feed containing untreated rapeseed oil (Group 1), chemically (randomly) interesterified rapeseed oil and tricaprin (Group 2),

chemically (randomly) interesterified rapeseed oil and coconut oil (Group 3), a physical mixture of rapeseed oil and coconut oil (Group 4), and untreated animal fat (Group 5), respectively.

Figure 4 shows the piglets' feed uptake by *ad lib.* feeding for 28 days (FU_p per piglet).

Figure 5 shows the piglets' daily weight gain as an average of 28 days.

Figure 6 shows the piglets' feed utilization calculated as FU_p per kg of weight gain during 28 days

DETAILED DESCRIPTION OF THE INVENTION

Interesterifications will be performed in batch using a catalyst such as sodium methoxide and an oil of vegetable or marine or animal origin as well as a source of short or medium chain fatty acids, which can be a triglyceride or a partial glyceride or a mixture of free fatty acids or just one free fatty acid. The interesterification can be performed with or without addition of solvents.

Alternatively, interesterification can be performed using an enzyme in soluble or in immobilized form as a catalyst. This process does not require addition of solvent and may therefore be considered beneficial to the environment and requires less safety precautions. The enzymatic conversion can be performed at lower temperatures than the chemical interesterification, typically 40-70°C. Alternatively, the enzymatic conversion can be performed using a fixed bed reactor and an immobilized lipase, which allows continuous operation. The process can be performed in one or more steps with intermediate removal of by-products. An example of a lipase that may be applied is Rhizomucor miehei lipase which may be used in

immobilised or free form and in batch reactors or in fixed bed reactors.

The ratio of the amounts of the fats used as starting material may be selected according to the incorporation of medium chain fatty acids that is intended in the final product and the incorporation at equilibrium of the process. This may be affected by the further purification process of the fat, which can include distillation or wintherization to remove by-products or surplus of starting material. The fats can be mixed with other ingredients directly or following moderate heating to 50 °C.

If the interesterification of the long chain oil is performed with free short or medium chain fatty acids a further advantage is obtained in that C16:0 (palmitic acid) can be removed during the process. A major part of this acid would otherwise be lost as the calcium salt in the piglets' faeces and, thus, would not provide available energy and lipid for storage and membrane structuring.

EXAMPLES

Example 1

Digestibility and balance study of piglets fed with rapeseed oil modified with tricaprin or capric acid

Purpose:

To study piglets' digestibility of nutrients and their protein depositions in a weaning period by comparing four feed mixtures containing different types of rapeseed oil modified with tricaprin (glyceryl tridecanoate) or capric acid (decanoic acid).

Materials and methods:

Four oil types were used:

1. Rapeseed oil
2. Rapeseed oil + tricaprin (2:1 by weight), chemically interesterified, random structure
3. Rapeseed oil + capric acid (2:1 by weight), enzymatically interesterified, specific structure
4. Rapeseed oil + tricaprin (2:1 by weight), physical mixture

On the basis of one basic feed mixture, four complete diet mixtures were prepared, each having a 10% content of one of the respective oil types. The complete diet mixtures had the following composition (percentage):

Rapeseed oil	10.0
Barley	28.8
Wheat	28.8
Soy meal	17.0
Fish meal - LT	12.0
Lysine (40%)	0.6
Feed chalk	0.4
Dicalcium phosphate	1.7
Salt	0.3
Sevit Mikro 4090	0.4

Each of the four feed mixtures was given to 6 pigs in the digestibility and balance study. In connection with weaning (4 weeks old), four piglets of the same litter and of the same sex were given separate feed mixtures. Two groups, each comprising four piglets of the same litter, were subjected to the study at the same time in order that the test could be conducted three times. Following one week of habituation, the piglets passed three balance periods of 5 days each. Between the periods, the daily amount of feed allotted to the piglets was increased for two days following a balance period with an invariable

amount of feed. During the balance periods, all faeces and urine were collected. The allotted feed amounts will appear from the list below:

Week 1 Monday, at about four weeks of age, the piglets are placed in metabolism cages in connection with weaning. A preparatory period starts where the piglets get conditioned to the feed and are allotted increasing amounts of feed, 100-250 g daily.

Week 2 Collection period A. Collection from Monday morning to Saturday morning with a steady feed amount of 250 g daily. From Saturday to Sunday the feed amount is increased to 400 g daily.

Week 3 Collection period B. A daily feed amount of 400 g. Collection from Monday morning to Saturday morning. From Saturday to Sunday the feed amount is increased to 500 g daily.

Week 4 Collection period C. A daily feed amount of 500 g. Collection from Monday morning to Saturday morning.

Week 5 The piglets are killed Monday morning (last feeding allotted Sunday evening).

Feed mixtures and faeces samples were analyzed as to their contents of dry matter, ash, nitrogen, fat (Stoldt) and crude fibre, and the gross energy was determined. Further, the feed mixtures were analyzed as to their contents of fatty acids, and the urine samples were analyzed for their nitrogen content.

The results of the digestibility and balance study were statistically analyzed in variance analyses (SAS), using

litter, collection period, and oil type as class variables. Mutual differences between the oil types were subsequently tested by use of the P-DIFF method (SAS) on LS-Means. In case of selected properties where significant differences between the oil types had been observed, corresponding analyses were conducted separately for the three collection periods.

Results

The average weight of the piglets at the beginning and at the end of the study was 8.4 kg and 15.7 kg, respectively. All the piglets passed the scheduled collection periods (a total of 72), however, one observation (litter 4, feed mixture 2, period 1) had to be omitted from the calculations, as the results for digestibility of several nutrients fell outside the normal range.

Results of the chemical analyses of the feed mixtures will appear from Table 1. This table shows that no significant differences in the contents of nutrients and gross energy of the mixtures were found.

Table 2 shows the results of fatty acid analyses conducted on the four feed mixtures. Only the fatty acids most significant in terms of quantity have been included. As expected, the fatty acid profiles for feed mixtures 2, 3, and 4 were different from that of feed mixture 1. The control mixture (1), to which untreated rapeseed oil had been added, had a low content of capric acid (C10:0), whereas in the mixtures 2, 3, and 4 the content of capric acid had been increased from 0.2 to about 2.5 g per 100 g of dry matter by way of adding the processed oil types to the feed. Consequently, the concentrations of the other fatty acids in these mixtures were correspondingly lower. No significant difference in the fatty acid profiles for the mixtures 2, 3, and 4 was observed.

Table 3 shows the main results of the digestibility and balance study. The values comprise all collection periods and are indicated as LS-Means. All digestibilities are calculated and indicated as apparent faecal digestibility (digestibility coefficient - DC). The digestibility of fat in the four feed mixtures was significantly different, whereas no significant differences in digestibility of the other nutrients in the feed were observed. The digestibility of the energy of the feed and the estimated content of metabolizable energy of the mixtures also exhibited significant differences in terms of the groups. As far as both fat and energy were concerned, the digestibility was improved by using the oil types which had been processed with C10:0, whereas no significant interactions were reported between these.

As also indicated in Table 3, the protein deposition of the piglets was affected by the oil types. Both the daily protein deposition and the deposition expressed as percentage of digested protein (BV) was improved by using, in particular, the esterified oil types (groups 2 and 3).

In terms of the three properties, digestibility of fat, daily protein deposition, and protein deposition in percentage of digested protein, Table 4 and Figures 1, 2, and 3 state the results separately for the individual collection periods. The improved digestibility of fat obtained with the C10:0 processed oil types is particularly pronounced in the first collection period. Likewise, the relative improvement in the daily protein deposition of the piglets was most significant in the first period, and so was the case with the relative deposition of digested protein. As regards the three properties mentioned, group 3, which had been allotted specifically interesterified rapeseed/C10:0 oil, obtained the highest values.

Conclusion

The results show that piglets allotted feed containing rapeseed oil which has been processed with C10:0, exhibit improved digestibility of the fat fraction of the feed. Thus, the piglets are fed more energy and their protein deposition is improved. In terms of both digestibility of fat and protein deposition, the interesterified oil types reflected the greatest improvements. The specifically interesterified oil type exhibited the greatest effect, which was in particular observed in the first collection week.

The results imply that in order to obtain maximum effect with specifically esterified lipids the piglets should be fed the test feed at an earlier stage.

Table 1: Analyzed chemical composition and determination of energy in feed mixtures

Feed mixture	1	2	3	4
Oil type	Rapeseed oil	Rapeseed oil + tricaprin interesterified, random	Rapeseed oil + capric acid interesterified, specific	Rapeseed oil + tricaprin physical mixture
% DM	89.7	89.6	89.7	89.8
per kg DM:				
Ash, g	64	64	64	65
Crude protein, g	267	264	262	267
Fat (Stoldt), g	143	141	142	139
Crude fibre, g	42	40	39	39
NFE, *g	484	491	493	490
Gross energy, MJ	20.99	20.95	21.03	21.00

* N-free extract substances calculated as difference

Table 2: Analyzed contents of the most significant fatty acids in the feed mixtures

Feed mixture	1	2	3	4
Oil type	Rapeseed oil	Rapeseed oil + tricaprin interesterified, random	Rapeseed oil + capric acid interesterified, specific	Rapeseed oil + tricaprin physical mixture
Fatty acid, g/100 g DM:				
Capric acid (C10:0)	0.18	2.43	2.38	2.68
Palmitic acid (C16:0)	1.11	0.94	0.91	0.95
Stearic acid (C18:0)	0.22	0.18	0.17	0.18
Oleic acid (C18:1)	6.01	4.60	4.48	4.39
Linoleic acid (C18:2)	3.08	2.58	2.56	2.46
Linolenic acid (C18:3)	0.95	0.71	0.67	0.71
Total fatty acids, g/100 g of Stoldt fat	84.9	84.2	83.6	85.8

Table 3: Digestibility of nutrients and estimated content of metabolizable energy in feed mixtures as well as protein deposition in piglets

Feed mixture	1	2	3	4	
Oil type	Rapeseed oil	Rapeseed oil + tricaprin interesterified, random	Rapeseed oil + capric acid interesterified, specific	Rapeseed oil + tricaprin physical mixture	SEM*
Digestibility, %:					
DM	85.4	85.8	85.6	85.7	0.4
Protein	85.8	85.7	84.9	85.2	0.6
Fat	80.2^{a}	84.1^{b}	84.3^{b}	83.2^{b}	1.0
Wood matter	52.1	49.4	48.4	50.9	1.8
NFE	91.9	92.1	91.2	92.2	0.4
Energy	84.7^{a}	85.9^{b}	85.5^{ab}	85.7^{ab}	0.4
Protein deposition:					
Av./day, g	54.9^{a}	57.8^{b}	58.6^{b}	56.2^{ab}	1.0
% of digested protein	68.6^{a}	72.8^{bc}	75.0^{c}	70.9^{ab}	1.2
Metabolizable energy:					
MJ per kg DM	17.03^{a}	17.35^{b}	17.29^{ab}	17.28^{ab}	0.09

*Standard Error of Mean

a, b, c: Results in the same line which do not have common letter, are significantly different ($P<0.05$)

Table 4: Digestibility of fat, daily protein deposition, and protein deposition in percent of digested protein (BV) in piglets in collection period A, B and C, respectively.

Feed mixture	1	2	3	4	
Oil type	Rapeseed oil	Rapeseed oil + tricaprin interesterified, random	Rapeseed oil + capric acid interesterified, specific	Rapeseed oil + tricaprin physical mixture	SEM*
Digestibility of fat, %:					
period A	73.7^{a}	80.7^{b}	82.2^{b}	76.1^{ab}	2.1
period B	85.0^{a}	84.4^{a}	84.8^{a}	86.3^{a}	0.9
period C	81.9^{a}	87.0^{b}	86.0^{b}	87.1^{b}	0.7
Average	80.2^{a}	84.1^{b}	84.3^{b}	83.2^{b}	1.0
Protein deposition per day, g:					
period A	30.4^{a}	34.1^{ab}	35.4^{b}	32.1^{ab}	1.4
period B	59.8^{a}	61.0^{a}	62.3^{a}	61.0^{a}	1.3
period C	71.3^{a}	78.9^{b}	78.1^{b}	75.4^{ab}	1.7
Average	54.9^{a}	57.8^{b}	58.6^{b}	56.2^{ab}	1.0
Protein deposition in % of digested protein:					
period A	60.6^{a}	68.3^{ab}	69.9^{b}	64.2^{ab}	2.8
period B	72.9^{a}	74.1^{ab}	77.1^{b}	74.3^{ab}	1.2
period C	71.5^{a}	76.8	77.9^{b}	74.2^{ab}	1.4
Average	68.6^{a}	$72.8^{b,c}$	75.0^{c}	70.9^{ab}	1.2

*Standard Error of Mean

a, b, c: Results in the same line which do not have common letter, are significantly different ($P<0.05$)

Example 2

Production study of piglets by ad lib. feeding after weaning using variously modified rapeseed oil types as the fat source

Purpose:

To study the effect of four variants of processed rapeseed oil in the feed for piglets on their feed uptake, weight gain, feed utilization, and health. Comparison was made to feed containing corresponding amounts of technical animal fat.

Materials and methods:

Feed mixtures

Four feed mixtures were prepared after the same formulation, but with addition of five different fat sources:

1. Rapeseed oil
2. Rapeseed oil + tricaprin, chemically interesterified
3. Rapeseed oil + coconut oil, chemically interesterified
4. Rapeseed oil + coconut oil, physical mixture
5. Technical animal fat

In each case the fat source comprised 10% of the finished feed mixture. The complete composition of the feed was:

	Test mixes %	Basic mix* %
Barley	28.4	31.55
Wheat	28.4	31.55
Soy meal	18.5	20.55
Fish meal - LT	12.0	13.40
Lysine (40%)	0.6	0.65
Feed chalk	0.2	0.20

Dicalcium phosphate	1.2	1.30
Salt	0.3	0.35
Sevit Mikro 4090	0.4	0.45
Fat - various sources	10.0	----

*Used as 90% basic feed + 10% fat of various sources

The feed mixtures were prepared as meal. A basic mixture was prepared which was divided in five portions for addition of its respective fat source.

Piglets

Piglets from 20 litters were allocated. They were weaned at an age of 28 days, following which five piglets from each litter were selected. They were styed for individual feeding with each their respective one of the five feed formulations. The five piglets from each litter were considered as one repetition (batch). They were fed according to appetite from a feed dispenser with the same feed formulation for four weeks following which the test treatment was concluded.

Recordings

The weight and feed uptake of the piglets were recorded at weekly intervals. Besides, for the first two weeks of the test period the consistency of their faeces was recorded on a daily basis (according to scale 0, 1, 2 wherein 0 is normal and 2 is severe diarrhoea). Treatments for diarrhoea and other occurrences of disorders were recorded.

Feed analyses

Analyses of the ready feed formulations were carried out while performing usual analysis of feed comprising dry matter, ash, nitrogen, HCl fat, cellulose and EDOMp. All

mixtures were also analysed for their contents of fatty acids. Aminoacid analysis was performed on mixture 1.

Results

Analysis results for the chemical composition of the feed formulation will appear from Table 5. The content of fat constituted approximately 15% of dry matter which was as expected. The contents of the remainder of nutrients in the formulations were also at the expected levels and with small variations. Accordingly, the calculated net energy content of the mixtures was within the range of 1.31 - 1.34 FUp per kg.

Table 6 shows the analysed fatty acid contents of the feed. The results reflect the types of fat sources. Mixture 1 - with rapeseed oil - had a relatively high content of C18:1 and C18:2. Mixture 2, where the rapeseed oil was interesterified with C10:0, had a relatively high content of this fatty acid, whereas mixtures 3 and 4, where the rapeseed oil was interesterified resp. mixed with coconut oil, had approximately identical profiles with relatively much C12:0. Mixture 5 - with animal fat - had a relatively high content of C16:0 and C18:0.

As planned, 20 by 5 piglets participated in the test. However, two piglets from group 1 had to be expelled due to poor growth. The properties: feed uptake, weight, weight gain and feed utilisation, were therefore based on a total of 98 observations. Table 7 lists non-corrected results for the weight and feed uptake of the piglets as recorded at weekly intervals.

Table 8 gives LS-means for properties relating to growth and feed uptake and utilisation. The results have been corrected with respect to effect of initial weight and litter (batch). Already after two weeks, the feed uptake

per pig was highest for group 2, and from then on the difference relative to groups 1, 4, and 5 remained significant. There was not at any time difference between groups 2 and 3, and at the conclusion of the test period group 3 exhibited a significant positive deviation from groups 4 and 5.

The daily weight gain of the piglets and their last recorded weight was significantly higher for group 2 than for the remaining groups. The difference in weight was considerable already after two weeks of testing. Group 3 differed significantly from group 1 following two weeks of testing, and from then on the relative lead was reduced to an insignificant level. Neither of the remaining groups differed significantly from each other as regards the weight and weight gain of the piglets.

Feed utilisation expressed as FUp per kg of weight gain was highest for group 2 and lowest for group 1. Owing to a large diversity of the results for this property, it was impossible to point to significant differences between the treatments. Figures 4, 5 and 6 illustrate the most important properties from Table 8.

From Table 9, the results of the recording of diarrhoea in the piglets are shown. Calculated on the basis of the entire material, diarrhoea was observed in 43% of the piglets. The total number of days where diarrhoea occurred was relatively low, ranging for the individual groups from between 12 and 22 days. This is to be seen in relation to a total number of feed days of 560. No significant difference between the groups was detected.

Conclusion

Comparison of the feed formulations added with the five different fat sources showed that piglets had the highest

feed uptake when the feed contained rapeseed oil interesterified with tricaprin (Group 2). The feed uptake in case of addition of rapeseed oil interesterified with coconut oil (group 3) was on an approximately identical level, whereas the remaining three treatments were not significantly different. Also, the weight gain of the piglets was highest for group 2, and there was a tendency towards a positive effect in group 3. The feed utilisation (FUp per unit of weight gain) was highest for group 2, the difference between teams not being statistically reliable, however. The positive deviations in the weight gain of the piglets in groups 2 and 3 manifested themselves already after two weeks of testing. The frequency of diarrhoea in the piglets was lowest for group 2, but the differences between test treatments were not significant.

Table 5: Results of chemical analyses on feed formulations

Feed mixture	1	2	3	4	5
Fat source	Rapeseed oil	Rapeseed + tricaprin	Rapeseed + coconut	Rapeseed + coconut	Animal fat
Treatment	untreated	interester. random	interester. random	physical mixture	untreated
% DM	90	905	91	91	90
g per kg DM:					
Ash	60	61	62	63	62
Crude protein	256	257	269	267	263
Fat (HCl)	148	150	157	150	152
Crude fibre	41	43	37	40	37
N-free extract sub.	494	489	476	482	486
$EDOM_{pig}$	90,1	89.7	89.9	89.9	89.7
FU_{pig} per kg	1.31	1.31	1.34	1.32	1.33

Table 6: Content of fatty acid in feed formulations, g of fatty acid/100 g of dry matter

Feed mixture	1	2	3	4	5
Fat source	Rapeseed oil	Rapeseed + tricaprin	Rapeseed + coconut	Rapeseed + coconut	Animal fat
Treatment	untreated	interester. random	interester. random	physical mixture	untreated
C10:0	-	2.69	0.23	0.22	-
C12:0	0.02	-	1.65	1.70	0.03
C14:0	0.07	0.07	0.71	0.71	0.25
C16:0	1.16	0.98	1.35	1.32	2.99
C16:1	0.07	0.08	0.09	0.09	0.36
C18:0	0.25	0.20	0.30	0.29	1.64
C18:1	6.42	4.42	4.33	4.31	4.63
C18:2	3.21	2.56	2.48	2.49	1.77
C18:3W3	0.01	0.78	0.70	0.71	0.19
C20:1W9	0.26	0.21	0.23	0.23	0.24
C20:5W3	0.11	0.13	0.17	0.17	0.17
C22:1W11	0.14	0.15	0.15	0.15	0.15
C22:6W3	0.18	0.19	0.21	0.19	0.22

Table 7: Weight and feed uptake of piglets recorded at weekly intervals

Feed mixture	1	2	3	4	5
Fat source	Rapeseed oil	Rapeseed + tricaprin	Rapeseed + coconut	Rapeseed + coconut	Animal fat
Treatment	untreated	interester. random	interester. random	physical mixture	untreated
No. of piglets	18	20	20	20	20
Av. weight, kg:					
at start	8.8	8.6	8.7	8.7	8.7
+ 1 week	9.1	9.5	9.2	9.1	9.2
+ 2 weeks	11.7	12.9	12.2	11.9	11.9
+ 3 weeks	16.1	17.4	16.6	16.4	16.1
+ 4 weeks	21.2	23.0	21.8	21.5	21.3
Feed uptake, kg:					
1. week	1.6	1.7	1.7	1.4	1.5
2. week	3.5	4.0	3.7	3.3	3.4
3. week	5.5	6.2	5.8	5.5	5.4
4. week	7.7	8.0	7.6	7.2	6.8
Total	18.3	19.8	18.9	17.4	17.0

Table 8: The feed uptake, weight and weight gain of the piglets, and feed utilisation given as LS-means (corrected for effect of initial weight and litter)

Feed mixture	1	2	3	4	5	
Fat source	Rapeseed oil	Rapeseed + tricaprin	Rapeseed + coconut	Rapeseed + coconut	Animal fat	SEM*
Treatment	untreated	interester. random	interester. random	physical mixture	untreated	
Feed uptake, kg:						
Week 1+2	4.2^{a}	5.6^{b}	5.4^{ab}	4.7^{a}	4.8^{a}	0.3
Week 1+2+3	10.4^{a}	11.8^{b}	11.2^{ab}	10.2^{a}	10.2^{a}	0.4
Week 1+2+3+4	18.0^{ab}	19.0^{c}	18.8^{bc}	17.4^{ab}	17.0^{a}	0.6
Total FU_p	23.6^{ab}	25.9^{c}	25.2^{bc}	22.9^{a}	22.6^{a}	0.8
Weight per piglet, kg:						
After 2 weeks	11.5^{a}	13.0^{c}	12.2^{b}	11.9^{ab}	11.9^{ab}	0.3
After 3weeks	15.8^{a}	17.5^{c}	16.6^{abc}	16.4^{ab}	16.1^{ab}	0.3
After 4weeks	20.9^{a}	23.1^{b}	21.8^{a}	21.5^{a}	21.3^{a}	0.4
Daily gain, g:						
Av of 4 weeks	435^{a}	515^{b}	468^{a}	457^{a}	451^{a}	14
FU_p per kg gain						
Av of 4 weeks	1.97^{a}	1.79^{a}	1.94^{a}	1.81^{a}	1.84^{a}	0.07

*Standard Error of Mean

a, b, c: Results in the same line which do not have common letter, are significantly different ($P<0.05$)

Table 9: Frequency of diarrhoea in the piglets

Feed mixture	1	2	3	4	5
Fat source	Rapeseed oil	Rapeseed + tricaprin	Rapeseed + coconut	Rapeseed + coconut	Animal fat
Treatment	untreated	interester. random	interester. random	physical mixture	untreated
No. of piglets:					
Without diarrhoea	11	13	9	13	11
With diarrhoea	9	7	11	7	9
No. of days:					
With diarrhoea, total	22	12	18	15	16
With diarrhoea, per piglet	1.1	0.6	0.9	0.8	0.8

CLAIMS

1. A method of feeding piglets in a weaning period which comprises feeding the piglets with a feed composition comprising from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

2. A method according to claim 1 wherein said special fat has been obtained by enzymatic or chemical interesterification of triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues with triglycerides having short or medium chain mainly saturated fatty acid residues or with short or medium chain mainly saturated fatty acids or esters thereof in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

3. A method according to claim 1 or 2 wherein the long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues are selected from the group consisting of fatty acid residues of from 16 to 24 carbon atoms, preferably from 18 to 22 carbon atoms.

4. A method according to any one of claims 1-3 wherein the short or medium chain mainly saturated fatty acid residues or fatty acids are selected from the group consisting of fatty acid residues and fatty acids of from 6 to 14 carbon atoms, preferably from 8 to 12 carbon atoms, and more preferably from 8 to 10 carbon atoms.

5. A method according to any one of claims 1-4 wherein said special fat is a so-called specifically structured lipid (SSL) consisting of triglycerides with short or medium chain fatty acid residues mainly occupying the sn-1.3 positions and long chain fatty acid residues mainly occupying the sn-2 positions, obtained by enzymatic interesterification with a regiospecific (1,3-specific) lipase.

6. A method according to any one of claims 1-4 wherein said special fat is a chemically or enzymatically interesterified triglyceride mixture consisting of triglycerides with short or medium chain fatty acid residues and long chain fatty acid residues occupying random positions.

7. A method according to any one of claims 1-6 wherein said special fat has been obtained by enzymatic or chemical interesterification of a vegetable or animal oil consisting of triglycerides with fatty acid residues having chain lengths mainly in the range of from 18 to 22 carbon atoms with fatty acids having chain lengths in the range of from 8 to 12 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with such fatty acid residues.

8. A method according to claim 7 wherein said special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with fatty acids of predominantly 8 and 10 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with predominantly such fatty acid residues.

9. A method according to claim 7 wherein said special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with tri-

caprin (glyceryl tridecanoate) or with capric acid (decanoic acid) or esters thereof.

10. A method of feeding piglets in a weaning period which comprises feeding the piglets with a feed composition comprising from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue.

11. A method according to any one of claims 1-10 wherein said feed composition is a basic weaning feed for piglets to which 4 to 15 percent by weight, preferably 6 to 12 percent by weight, of said special fat has been added.

12. A method according to any one of claims 1-11 wherein the piglets are fed with said feed composition during a weaning period within their 3rd to 8th week of life (ie from age 2 weeks to age 8 weeks).

13. A method according to claim 12 wherein the piglets are fed with said feed composition during the first two weeks after weaning.

14. Use of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2, for the manufacture of a weaning feed for piglets.

15. The use according to claim 14 wherein said special fat has been obtained by enzymatic or chemical inter-

esterification of triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues with triglycerides having short or medium chain mainly saturated fatty acid residues or with short or medium chain mainly saturated fatty acids or esters thereof in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

16. The use according to claim 14 or 15 wherein the long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues are selected from the group consisting of fatty acid residues of from 16 to 24 carbon atoms, preferably from 18 to 22 carbon atoms.

17. The use according to any one of claims 14-16 wherein the short or medium chain mainly saturated fatty acid residues or fatty acids are selected from the group consisting of fatty acid residues and fatty acids of from 6 to 14 carbon atoms, preferably from 8 to 12 carbon atoms, and more preferably from 8 to 10 carbon atoms.

18. The use according to any one of claims 14-17 wherein the special fat is a so-called specifically structured lipid (SSL) consisting of triglycerides with short or medium chain fatty acid residues mainly occupying the sn-1.3 positions and long chain fatty acid residues mainly occupying the sn-2 positions, obtained by enzymatic interesterification with a regiospecific (1,3-specific) lipase.

19. The use according to any one of claims 14-17 wherein the special fat is a chemically or enzymatically interesterified triglyceride mixture consisting of triglycerides with short or medium chain fatty acid residues and long chain fatty acid residues occupying random positions.

20. The use according to any one of claims 14-19 wherein the special fat has been obtained by enzymatic or chemical interesterification of a vegetable or animal oil consisting of triglycerides with fatty acid residues having chain lengths mainly in the range of from 18 to 22 carbon atoms with fatty acids having chain lengths in the range of from 8 to 12 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with such fatty acid residues.

21. The use according to claim 19 wherein the special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with fatty acids having predominantly 8 and 10 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with predominantly such fatty acid residues.

22. The use according to claim 19 wherein said special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with tricaprin (glyceryl tridecanoate) or with capric acid (decanoic acid) or esters thereof.

23. The use of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue, for the manufacture of a weaning feed for piglets.

24. A weaning feed for piglets which comprises from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of interesterified triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues and short or medium chain mainly saturated fatty acid residues in a molar ratio between long chain fatty acids and short or

medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

25. A weaning feed according to claim 24 wherein the special fat has been obtained by enzymatic or chemical interesterification of triglycerides having long chain mainly unsaturated, preferably polyunsaturated, fatty acid residues with triglycerides having short or medium chain mainly saturated fatty acid residues or with short or medium chain mainly saturated fatty acids or esters thereof in a molar ratio between long chain fatty acids and short or medium chain fatty acids of from 5:1 to 1:5, preferably from 3:1 to 1:3, and more preferably from 2:1 to 1:2.

26. A weaning feed according to claim 24 or 25 wherein the long chain mainly unsaturated, preferentially polyunsaturated, fatty acid residues are selected from the group consisting of fatty acid residues of from 16 to 24 carbon atoms, preferably from 18 to 22 carbon atoms.

27. A weaning feed according to any one of claims 24-26 wherein the short or medium chain mainly saturated fatty acid residues or fatty acids are selected from the group consisting of fatty acid residues and fatty acids of from 6 to 14 carbon atoms, preferably from 8 to 12 carbon atoms, and more preferably from 8 to 10 carbon atoms.

28. A weaning feed according to any one of claims 24-27 wherein the special fat is a so-called specifically structured lipid (SSL) consisting of triglycerides with short or medium chain fatty acid residues mainly occupying the sn-1.3 positions and long chain fatty acid residues mainly occupying the sn-2 positions, obtained by enzymatic interesterification with a regiospecific (1,3-specific) lipase.

29. A weaning feed according to any one of claims 24-27 wherein the special fat is a chemically or enzymatically interesterified triglyceride mixture consisting of triglycerides with short or medium chain fatty acid residues and long chain fatty acid residues occupying random positions.

30. A weaning feed according to any one of claims 24-29 wherein the special fat has been obtained by enzymatic or chemical interesterification of a vegetable or animal oil consisting of triglycerides with fatty acid residues having chain lengths mainly in the range of from 18 to 22 carbon atoms with fatty acids having chain lengths in the range of from 8 to 12 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with such fatty acid residues.

31. A weaning feed according to claim 30 wherein the special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with fatty acids having predominantly 8 and 10 carbon atoms or esters thereof or with an MCT oil consisting of triglycerides with predominantly such fatty acid residues.

32. A weaning feed according to claim 30 wherein the special fat has been obtained by enzymatic or chemical interesterification of rapeseed oil or soybean oil with tricaprin (glyceryl tridecanoate) or with capric acid (decanoic acid) or esters thereof.

33. A weaning feed for piglets which comprises from 2 to 30 percent by weight, preferably from 4 to 15 percent by weight, of a special fat consisting of triglycerides each having at least one long chain mainly unsaturated, preferably polyunsaturated, fatty acid residue and at least one short or medium chain mainly saturated fatty acid residue.

34. A weaning feed according to any one of claims 24-33 which is a basic weaning feed for piglets to which 4 to 15 percent by weight, preferably 6 to 12 percent by weight of the special fat has been added.

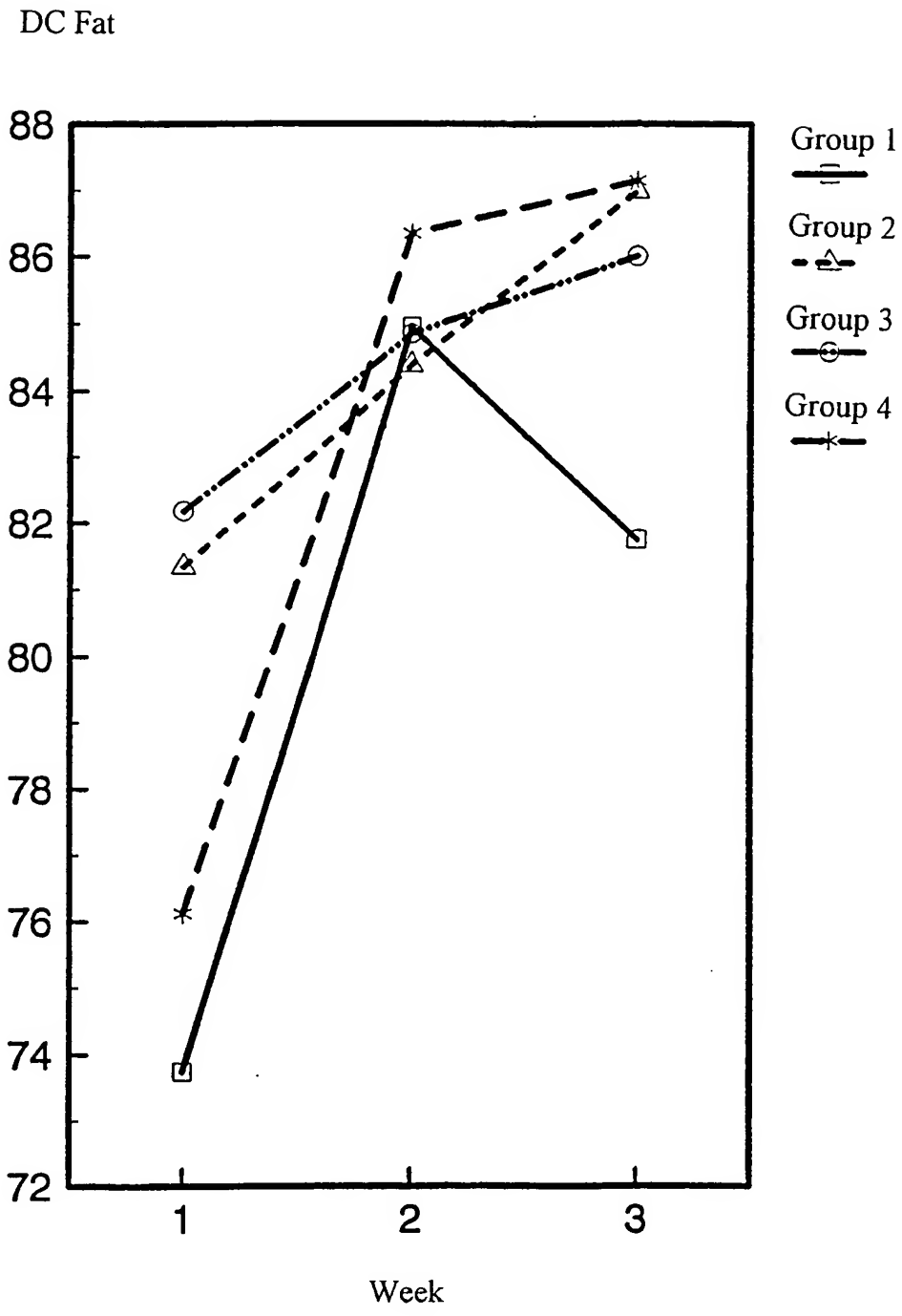
DC Fat
88
86
84
82
80
78
76
74
72
1
2
3
Week
Group 1
Group 2
Group 3
Group 4

Fig. 1

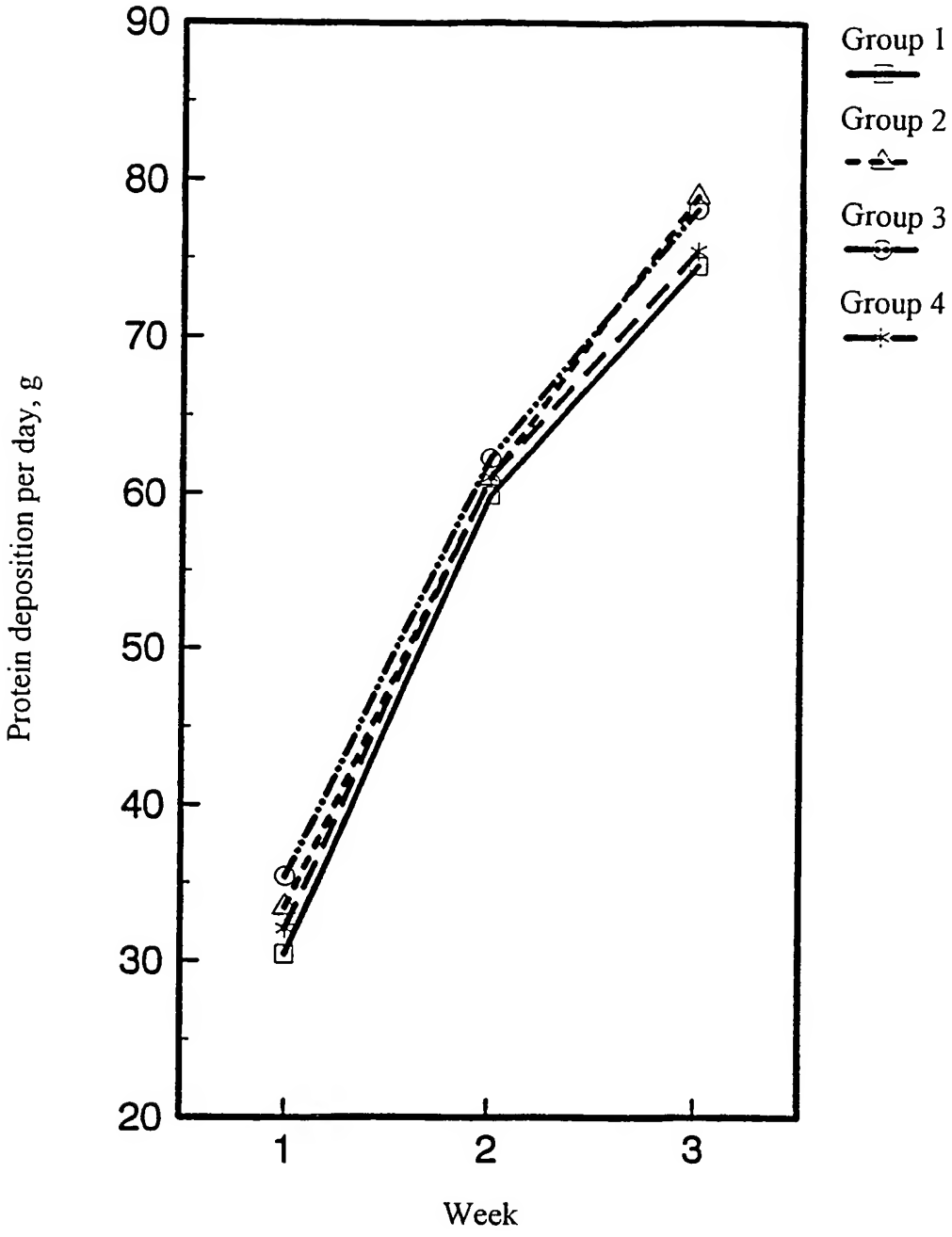
90
80
70
60
50
40
30
20
1
2
3
Week
Protein deposition per day, g
Group 1
Group 2
Group 3
Group 4

Fig. 2

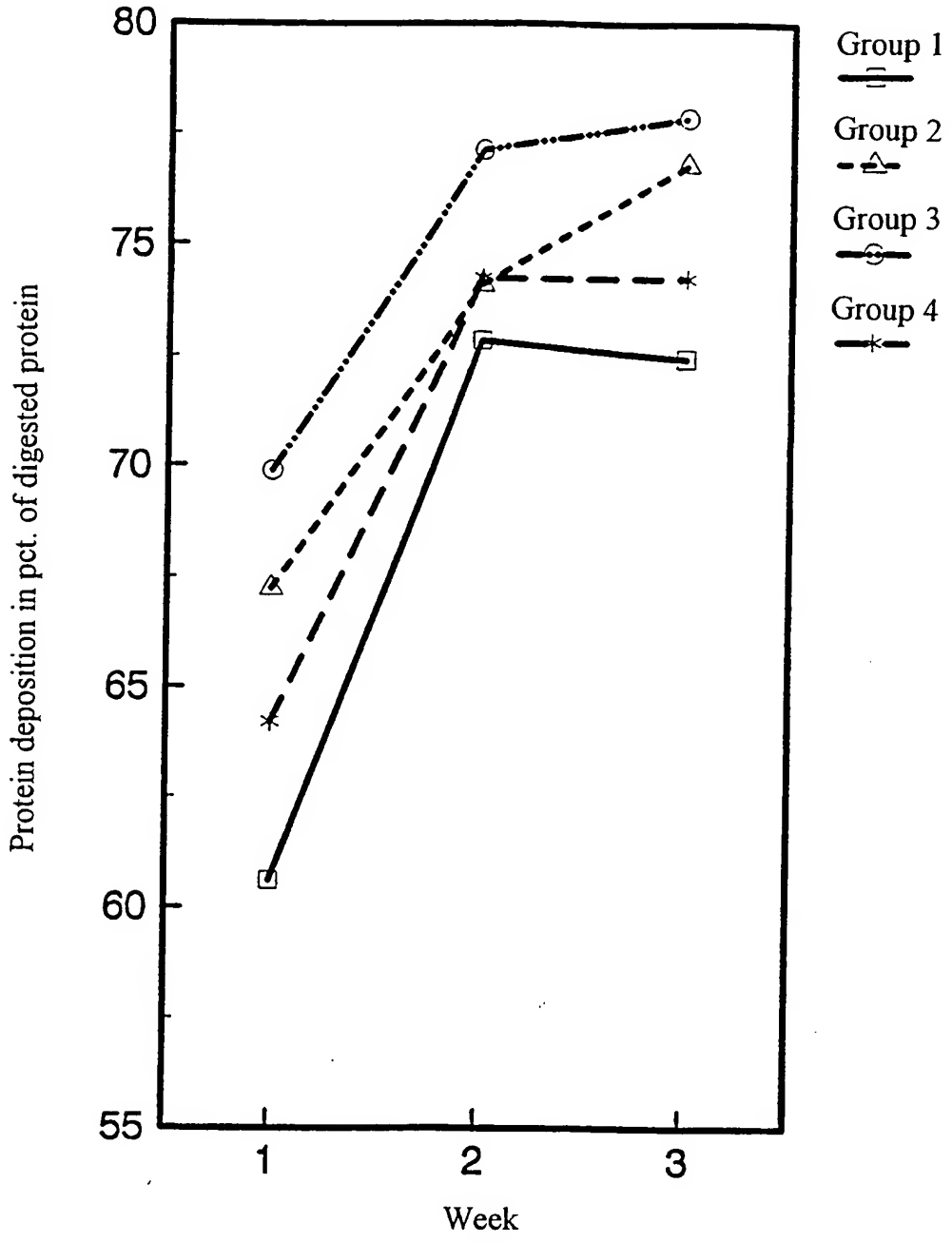
80
75
70
65
60
55
1
2
3
Week
Protein deposition in pct. of digested protein
Group 1
Group 2
Group 3
Group 4

Fig. 3

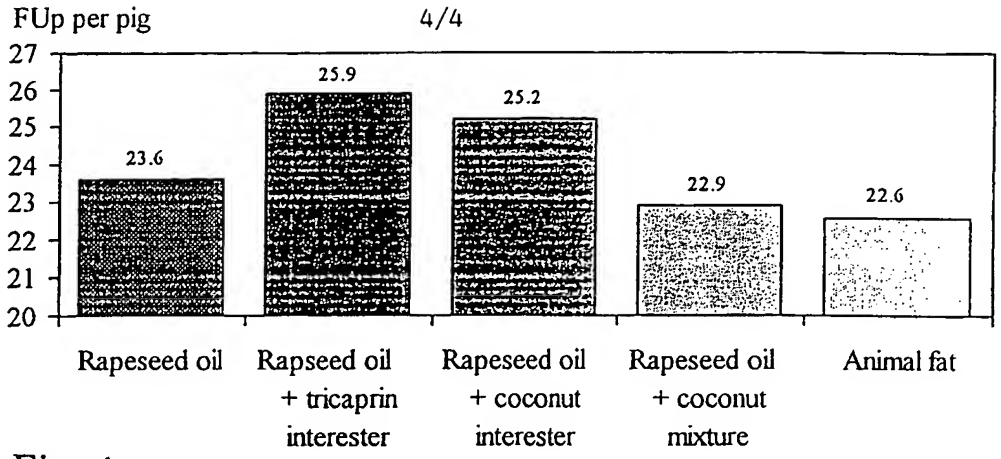

Fig. 4

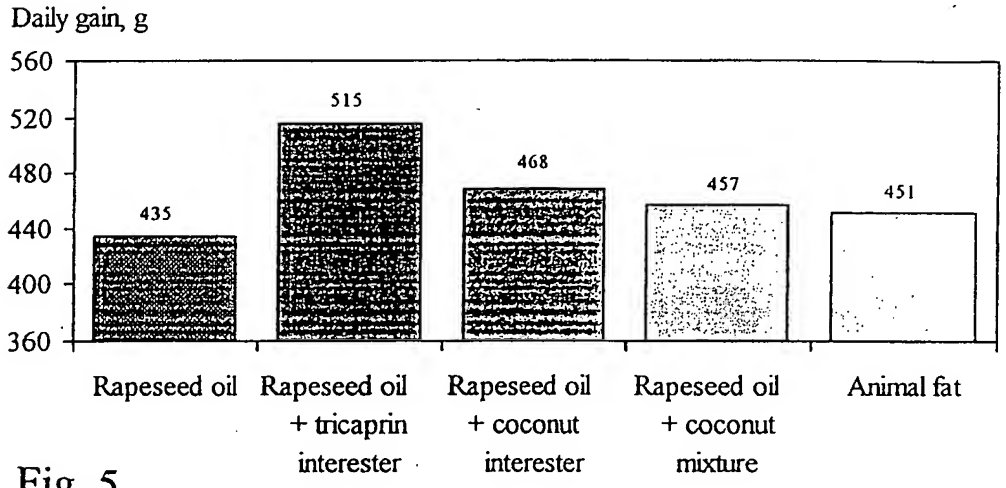

Fig. 5

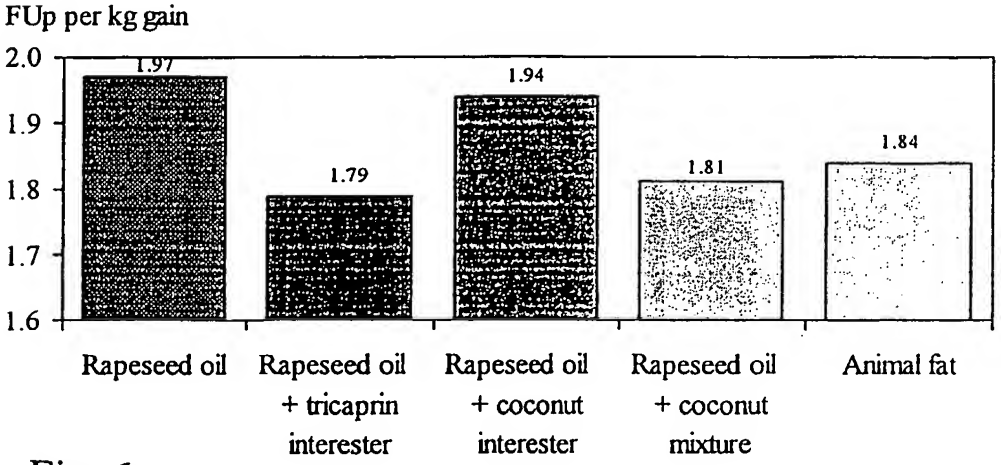

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00369

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A23K 1/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A23K, C11C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CAPLUS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9012858 A1 (NOVO NORDISK A/S), 1 November 1990 (01.11.90) --	1-34
Y	JAOCS, Volume 76, No 2, 1999, X. Xu et al, "Parameters Affecting Diacylglycerol Formation During the Production of Specific-Structured Lipids by Lipase-Catalyzed Interesterification", page 175 - page 181, column 2, line 7 to line 15 --	1-34
Y	EP 0600439 A2 (KAO CORPORATION), 8 June 1994 (08.06.94), page 3, line 22 to line 37; claims 1 and 3 --	1-34

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 October 2000	09. 11. 2000
Name and mailing address of the ISA/ European Patent Office Facsimile No.	Authorized officer DAGMAR JÄRVMAN/EÖ Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/DK 00/00369

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9012858 A1	01/11/90	AT 81150 T	15/10/92
		CA 2055455 A	20/10/90
		DE 69000362 D,T	04/03/93
		DK 190689 D	00/00/00
		DK 469049 T	15/02/93
		EP 0469049 A,B	05/02/92
		ES 2035751 T	16/04/93
		JP 4504659 T	20/08/92
EP 0600439 A2	08/06/94	CN 1050732 B	29/03/00
		CN 1092934 A	05/10/94
		DE 69321560 D,T	08/04/99
		ES 2123607 T	16/01/99
		JP 3068970 B	24/07/00
		JP 6153811 A	03/06/94
		US 5686490 A	11/11/97
GB 2277862 A	16/11/94	GB 9309723 D	00/00/00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 00/00369

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2277862 A (NUTEC LTD), 16 November 1994 (16.11.94), abstract; page 4, line 21 to line 27; claims 1 and 4	1-34

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